

THE CONJUGATE ADDITION OF A CARBONYL ANION EQUIVALENT TO ELECTRON DEFICIENT OLEFINS  
 A NOVEL AND EFFICIENT SYNTHESIS OF 1,4-DICARBONYL SYSTEMS

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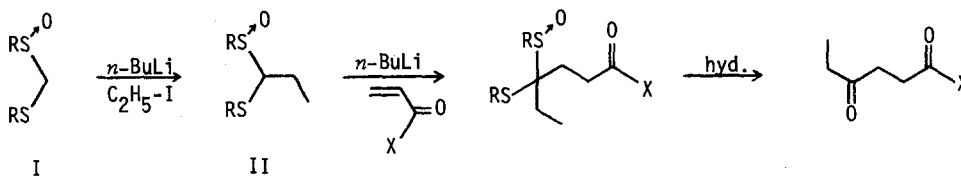
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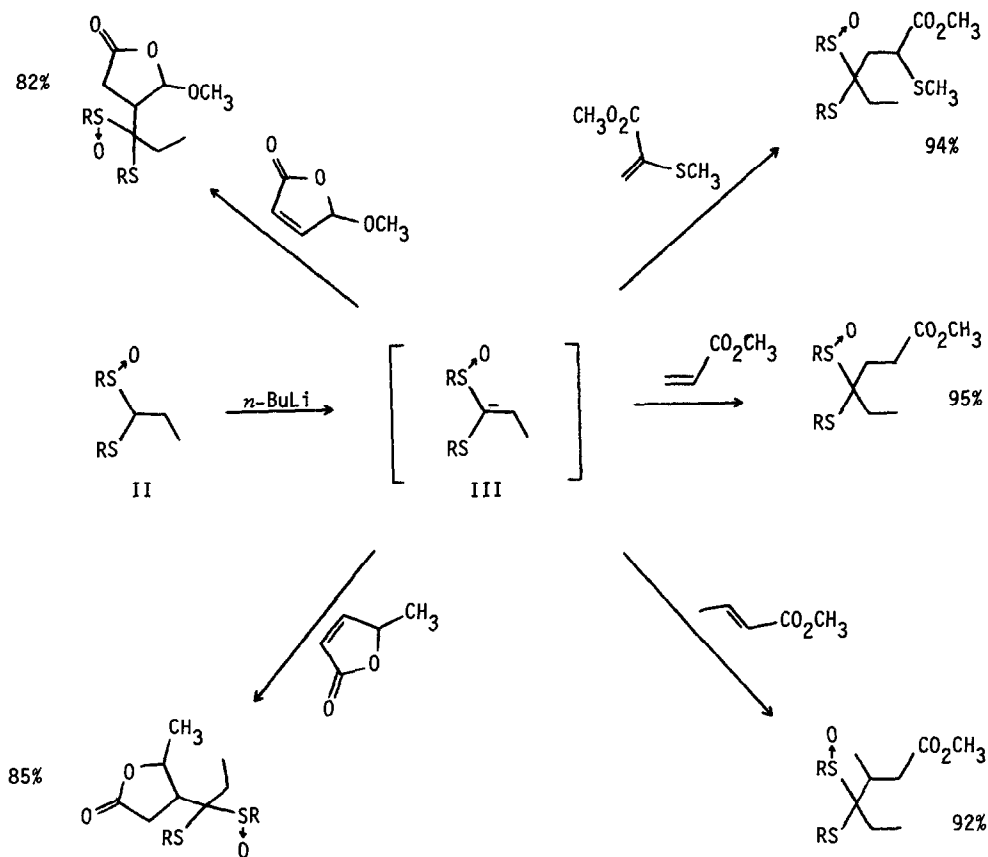
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In the preceding communication we proposed a "linch-pin" strategy for the construction of unsymmetrically substituted 1,4-dicarbonyl compounds.<sup>1</sup> The salient requirement of this synthetic method was the development of a carbonyl anion equivalent able to undergo both alkylation as well as conjugate addition, and hence to tactically serve as the "linch-pin" component of the method. In order to realize this proposition, we have studied the carbonyl anion equivalent I, (R = C<sub>2</sub>H<sub>5</sub>) and have reported a viable procedure for the high yield alkylation of this species.<sup>1</sup>

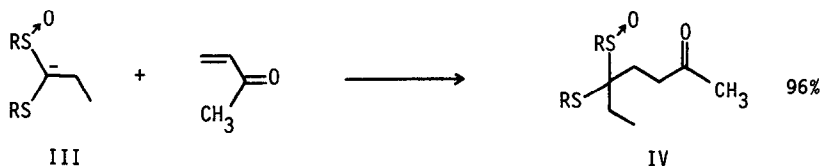
Herein, we wish to describe the successful conjugate addition of the carbonyl anion equivalent II, to electron deficient olefins. These results provide the first examples of an efficient "linch-pin" assemblage of 1,4-dicarbonyl systems which utilizes a carbonyl anion equivalent that is not stabilized by a transition metal.<sup>2</sup>



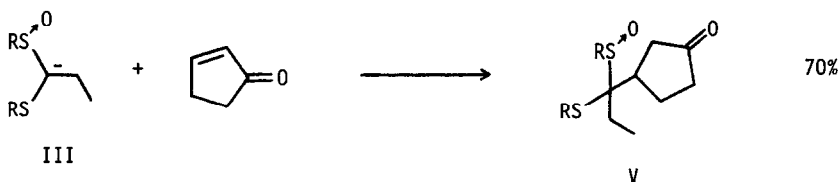
The thioacetal monosulfoxide II may be prepared either from I or from propionaldehyde by methods already described.<sup>1</sup> A solution of II (1 equivalent, 1 molar in THF) when treated at 0° with *n*-butyllithium (1 equivalent) quantitatively affords the anion III (20 minutes).<sup>3</sup> This anion undergoes smooth conjugate addition with a variety of unsaturated esters and lactones. These reactions are carried out by simply adding a 1.8 molar THF solution of the olefin (1.1 equivalents) to the anion III (1 equivalent, 1 molar in THF) at -78°, and then stirring the resulting mixture at this temperature for 2 hours. A summary of some typical Michael reactions of this type are given below.<sup>4</sup>



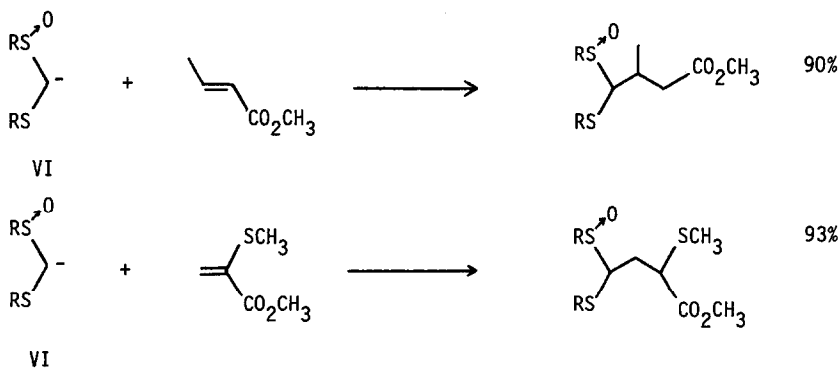
Anion III also undergoes very high yield conjugate addition to acyclic unsaturated ketones. Reactions of this type are best carried out by generating the anion III as previously described in THF solution followed by addition of the ketone (0.9 equivalents, 1.0 molar in THF) at  $-20^{\circ}$ . The reaction of methyl vinyl ketone with III to give the conjugate addition product IV (96% yield) is typical of ketones of this type.<sup>5</sup>



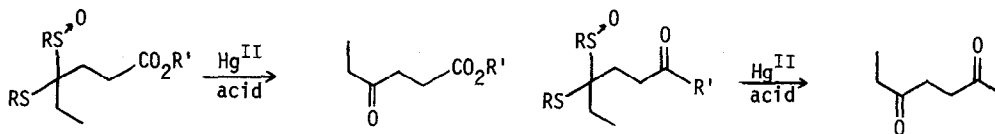
Cyclopentenone (2 equivalents) undergoes reaction with III (1 equivalent) at  $-20^{\circ}$  to give the Michael product V in 70% yield. However, cyclohexenone and derivatives of it undergo combination with III in only modest yield.<sup>6</sup>



The unsubstituted thioacetal monosulfoxide anion VI also undergoes smooth conjugate addition with unsaturated esters.<sup>7</sup> It should be noted, however, that the anion VI does not undergo Michael addition to unsaturated ketones, but rather adds to the carbonyl moiety of these systems.<sup>8</sup>



All of the Michael products produced from both III and VI undergo smooth hydrolytic conversion into their corresponding carbonyl analogues using the procedures previously reported.<sup>1</sup>



On the basis of the results given above, it is clear that efficient "linch-pin" constructions of a variety of 1,4-dicarbonyl systems can be easily realized using the carbonyl anion equivalents I and II. Furthermore, this method should be of preparative significance since the reactions described are compatible with nearly ideal stoichiometry.

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#### REFERENCES

1. J. E. Richman, J. L. Herrmann, and R. H. Schlessinger, *Tetrahedron Letts.*, in press.
2. This type of construction using a sulfur stabilized carbonyl anion equivalent has recently been realized by T. Mukaiyama, K. Narasaka, and M. Furusato, *J. Amer. Chem. Soc.*, **94**, 8641 (1972). In this case the conjugate addition step was carried out *via* an organo copper intermediate. The reported stoichiometry of these reactions utilized a 100% excess of these organo copper reagents.
3. The extent of anion formation was determined by quenching with D<sub>2</sub>O.
4. The yields given are for isolated products and are based on the amount of II used. All compounds exhibited satisfactory spectral and physical properties.
5. Yield based on the amount of ketone used.
6. The yields obtained for cyclohexenone and analogues of it are between 50 and 60%. Self-condensation of the enone seems to be the major side reaction in these cases.
7. The reactions of VI are best carried out in a manner identical to that described for anion III.
8. Acylation of anion such as III and VI will be the subject of a subsequent communication.